WEIGHTS AND FAT CONDITION OF SOME MIGRANT WARBLERS IN JAMAICA

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In the Old World, deposition of fat before migrating has been described in both summer and winter quarters of many Palaearctic bird species (references in Pearson 1971), but in the New World there has been only one study outside continental North America (Rogers and Odum 1966). During a study of the annual cycles of forest birds in Jamaica (Diamond 1974), we caught over 400 parulid warblers of 19 species (see also Diamond and Smith 1973, Lack and Lack 1973). This paper describes the variation in weight and visible fat condition of 302 of the 7 most commonly caught species; mean weights of all the migrant warblers caught are given in an Appendix. Warblers were caught between October 1970 and May 1971 by A. W. D. and P. L., in August and September 1971 by A. W. D. and from September 1971 to April 1972 by R. W. S. and S. Gowen. Nomenclature follows Bond (1971) for birds, and Adams (1972) for plants.

TRAPPING SITES AND METHODS

The 4 main trapping sites (Fig. 1a) were as follows:

Port Henderson Hill.—Altitude 155 m. Low xeric scrub ("dry limestone scrub forest" of Asprey and Robbins 1953), much disturbed by cutting for charcoal, rarely exceeding 3 m high, and dominated by red birch ("Gumbo Limbo") (*Bursera simaruba*) and the tall cactus *Stenocereus hystrix*;

Mona Woods.—Altitude 185 m. A small patch of secondary riverine forest, with a canopy 15 to 18 m high and a dense undergrowth of shrubs and creepers. Most birds were caught beside a stream leading out of the Mona Reservoir;

Irish Town.—Altitude 770 m. A small garden on the crest of a ridge, with thick scrub on the slopes and secondary forest, mostly of native trees, in the valley on one side;

Green Hills.—Altitude 1080 m. The garden of the Institute of Jamaica Field Station, surrounded by montane forest, on the northern (windward) side of the western end of the Blue Mountain range.

All the birds were caught in mist nets, mostly between dawn and noon but some, especially at Irish Town, in the evening. All birds were weighed to the nearest 0.25 g on a "Pesola" spring balance with a range of 0–50 g.

Subcutaneous fat was estimated as follows (Diamond 1974): each of 4 areas of the body (furculum, axilla, abdomen, and rump) was scored independently, on a scale from 0 (no fat) to 3 (fat mounded), giving a summed possible range of scores of 0–12. Fat score and weight were correlated (Spearman's rho $= 0.3$, $p < .01$), but the relationship is weak enough that weight and fat score did not always vary in parallel.

Insufficient data were obtained for a detailed analysis of diurnal changes in weight or fat in any one species. However when all 7 species were treated together, weights taken before 10:00 were significantly less (by about 5%) than those taken after 10:00

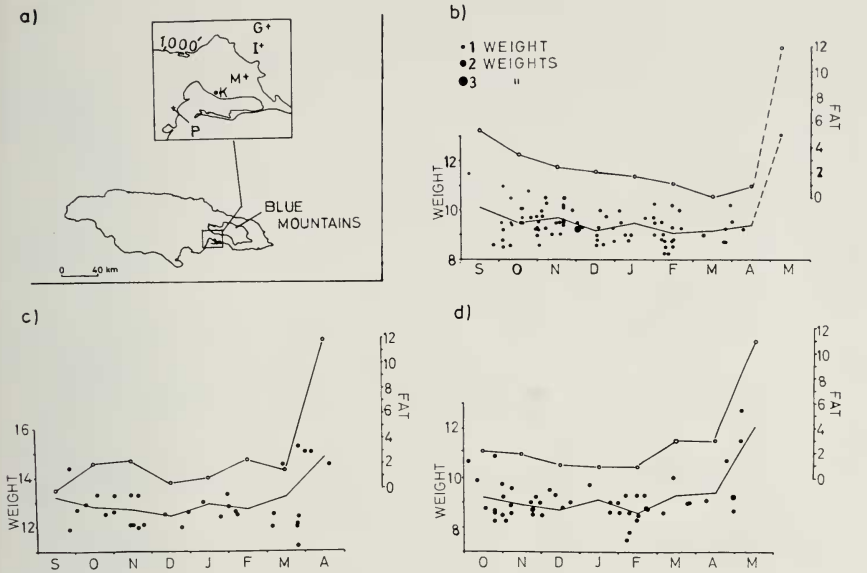

FIG. 1. (a) Sketch map of Jamaica. Inset: location of netting sites described in text. (b)–(d) Changes in weight and visible subcutaneous fat through the winter for (b) Black-and-white Warbler, (c) Worm-eating Warbler, and (d) Black-throated Blue Warbler. Individual weights are shown as solid circles; a solid line connects monthly means. Open circles show monthly median fat scores. Weight and fat are corrected for diurnal variation (see text).

($p < .001$, 2-tailed t-test). Fat scores before 10:00 also averaged 60% lower than those after 10:00 ($p < .001$, 2-tailed median test). Unless noted otherwise, all weights and fat scores in this paper are "morning" ones, those after 10:00 having been corrected by subtracting 5% (weight) or 60% (fat score). Weight loss of birds kept overnight was greater than 5%, averaging 8.9% (12 birds); 5% represents the average weight difference over a time period varying from 0 to 12 h, and so is less than the weight lost overnight, i.e. over 12 h.

In 4 species it has been possible to compare the weights from Jamaica with weights from a North American breeding area, the Powdermill banding station in Pennsylvania (referred to below simply as "Pennsylvania"); Powdermill weights from June and July only have been used, since birds caught then are likely to be local breeders rather than migrant birds. The other 3 species were not caught regularly in the summer at Powdermill so for comparison we have used weights given by Baldwin and Kendeigh (1938) and Wetherbee (1934) although these, like our Jamaican weights, may include some migrant birds.

SPECIES ACCOUNTS

Black-and-white Warbler (*Mniotilta varia*).—These were common throughout the island, and were seen from early September through May. This was

one of 2 species caught regularly at all 4 trapping sites. Fat score declined gradually through the winter (Fig. 1 b); weight remained steady, but weights of retrapped birds (Table 1) appeared to decrease slightly through the winter. The few birds caught in April were slightly heavier than those trapped in March, and the single bird caught in May had the maximum possible fat score and was about 25% heavier than any bird caught during the winter. Winter weights were significantly lower than the mean weight (10.9 g) of 15 birds caught in Pennsylvania in June and July (2-tailed t-test, $p < .001$), and several February weights were below the lowest weight (8.5 g) recorded by Drury and Keith (1962) in migrant birds.

Worm-eating Warbler (*Helmitheros vermivorus*).—Widespread from late September to April. This rather skulking species fed mainly in undergrowth and was caught at all the trapping sites except Port Henderson. The few birds caught in September were lean; fat scores rose thereafter, except in December, but weights remained steady through the winter until March, when both weight and fat score rose sharply (Fig. 1 c). One individual retrapped in late March was 21% heavier than in early February.

Black-throated Blue Warbler (*Dendroica caerulescens*).—This species arrived later than most others, none being caught before October; it was caught in all the trapping sites except Port Henderson. Weight and fat declined slightly from October through February, rising thereafter to a maximum in May (Fig. 1 d). The weights of the 2 birds retrapped in May were 46% and 62% higher than their respective winter weights (Table 1). Several birds caught in October and November were considerably heavier than most caught during the winter. Two birds weighed in February were close to the fat-free weight of 7.6 g given by Connell et al. (1960).

Prairie Warbler (*Dendroica discolor*).—Found mainly in the lowlands, Prairie Warblers were caught between late August and April, most commonly at Port Henderson but also at Mona Woods and Irish Town. Weight and fat were high in autumn and spring, low from October through March (Fig. 2 a). The average weight of 3 immatures in summer, 7.2 g (Wetherbee 1934), is higher than most winter weights.

Ovenbird (*Seiurus aurocapillus*).—This and the Black-and-white Warbler were the only species caught regularly at all trapping sites. Most birds were lean in September and October (Fig. 2 b), and weights increased from September through November, then remained steady until March. The few individuals caught in April were the fattest and heaviest Ovenbirds caught during the study, and one bird caught twice in April increased in weight by 41% in 20 days. Most winter weights were below the mean weight of 19.7 g given by Wetherbee (1934) and Baldwin and Kendeigh (1938) for 15 birds between May and August, but were not significantly different from those of 16

TABLE 1
WEIGHT CHANGES IN RETRAPPED INDIVIDUAL WARBLERS

Black-and-white Warbler

A*	18 Oct—9.75**	F	17 Nov—9.5	K	30 Nov—9.5
	8 Jan—9.0		16 Dec—9.0		21 Feb—9.25
			12 Jan—9.0		25 Mar—9.25
B	31 Oct—9.25		8 Mar—9.0		
	1 Nov—8.5			L	24 Jan—9.75
	6 Nov—9.25	G	20 Nov—10.25		30 Jan—9.75
			11 Dec—9.5		6 Feb—9.5
C	31 Oct—9.0				
	4 Dec—9.25	H	1 Dec—9.25	M	20 Feb—10.0
	14 Feb—9.25		16 Dec—8.5		25 Mar—8.75
			8 Feb—8.25		
D	3 Nov—10.0			N	18 Oct—9.5
	29 Mar—10.25	I	16 Dec—9.0		28 Nov—9.0
			15 Feb—8.75		
E	6 Nov—10.5			O	7 Nov—10.25
	31 Jan—10.25	J	1 Feb—9.0		4 Dec—9.5
			9 Feb—8.5		

Worm-eating Warbler

A	1 Nov—12.5	C	18 Oct—13.25	E	6 Feb—12.5
	23 Jan—12.5		16 Nov—13.75		25 Mar—15.25
B	14 Nov—12.0	D	14 Nov—11.5	F	17 Oct—12.75
	5 Mar—12.0		29 Dec—12.5		27 Nov—12.5
			24 Mar—12.0		

Black-throated Blue Warbler

A	31 Oct—9.75	D	14 Feb—8.25	H	3 Nov—8.25
	24 Jan—9.0		20 Feb—8.75		16 Nov—9.25
	30 Jan—9.0				24 Nov—8.75
	14 Feb—9.25	E	24 Nov—8.75		8 Jan—9.75
			5 May—12.75		
B	24 Nov—8.5			I	17 Dec—8.75
	7 Feb—7.5	F	13 Mar—10.0		23 Dec—9.0
			25 Apr—10.75		
C	7 Dec—9.5			J	24 Dec—7.0
	6 Feb—9.25	G	24 Oct—11.0		5 May—11.5
			30 Apr—10.0		

Table 1 (Continued)

Ovenbird					
A	31 Oct—16.5	C	12 Jan—19.5	F	29 Oct—20.0
	30 Nov—17.5		15 Feb—19.5		12 Nov—20.25
	29 Dec—17.0				
	20 Jan—17.0	D	24 Mar—19.5	G	11 Dec—19.0
	31 Jan—15.25		31 Mar—20.25		23 Dec—19.5
B	23 Oct—19.0	E	28 Nov—18.25	H	23 Jan—19.0
	8 Apr—17.5		12 Dec—18.5		30 Jan—19.25
	28 Apr—24.5				
				I	24 Nov—19.25
					24 Dec—20.25
Common Yellowthroat					
A	23 Dec—9.5	D	19 Nov—9.0	G	2 Oct—11.25
	11 Jan—9.75		9 Feb—9.25		11 Dec—10.25
			16 Feb—9.25		
B	1 Feb—10.25			H	11 Dec—10.5
	9 Feb—9.75	E	29 Dec—9.0		28 Apr—10.0
			30 Jan—9.0		
C	16 Feb—10.5			I	11 Dec—10.5
	24 Mar—9.75	F	8 Nov—9.75		8 Apr—8.75
			25 Apr—11.5		
Prairie Warbler					
A	17 Nov—6.5	B	17 Nov—6.25		
	12 Jan—6.5		8 Mar—6.5		
	15 Feb—6.5				
American Redstart					
A	1 Nov—7.0	B	14 Feb—7.0		
	29 Dec—6.5		5 Mar—7.0		
	24 Jan—6.5				

* Dates and weights for each lettered group indicate successive captures of one individual.
** Weight in grams.

birds caught in Pennsylvania in June and July and were well above the mean fat-free weight of 16.0 g given by Rogers and Odum (1966).

One bird, retrapped 5 times at Irish Town, dropped in weight suddenly in January and was not caught again (Table 1); its last recorded weight was about 20% below the average winter weight.

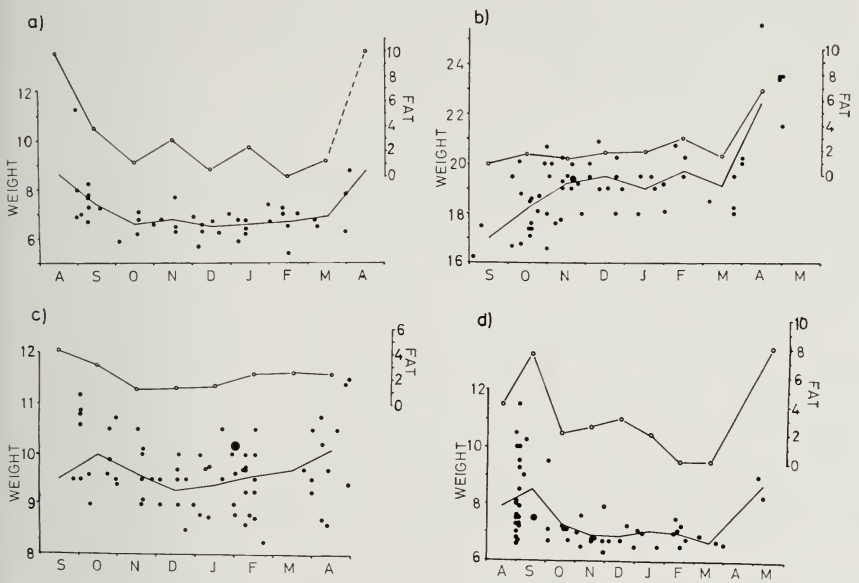

FIG. 2. As Fig. 1 (b)–(d). (a) Prairie Warbler. (b) Ovenbird. (c) Common Yellowthroat. (d) American Redstart.

Common Yellowthroat (*Geothlypis trichas*).—Present from September through April, Yellowthroats favored dense undergrowth and long grass; most were caught in Mona Woods, where both these habitats abound, but a few were trapped at Irish Town and Green Hills. Weight and fat were as high in autumn as in spring (Fig. 2 c). Most winter weights were below the 10.4 g mean of 24 summer weights given by Wetherbee (1934) and Baldwin and Kendeigh (1938), but did not differ significantly from those of 60 birds weighed in Pennsylvania in June and July.

American Redstart (*Setophaga ruticilla*).—We caught this species between late August and mid-May (although according to Bond (1971) it is found throughout the year in the Greater Antilles) in all habitats but most commonly at Port Henderson. Autumn weights were very variable, and many were higher than the few spring weights obtained (Fig. 2 d). Both fat score and weight declined from September through November; fat apparently declined again from January through March, while weight remained constant, but this apparent difference may be due to the small number of birds scored for fat during this period. Most winter weights were within the range of fat-free weights (6.6 to 7.1 g) given by Rogers and Odum (1964), and most

were below the lowest weight (7.1 g) recorded by Drury and Keith (1962) in migrant birds; the mean weight of birds caught in Jamaica was significantly lower than the mean (8.6 g) of 25 birds caught in June and July in Pennsylvania (2-tailed t-test, $p < .001$).

DISCUSSION

All the species described here increased in both weight and fat score prior to the spring migration. As has been found in North American migrants leaving Central America (Rogers and Odum 1966) and in Palaearctic migrants leaving Africa (Pearson 1971), very few fat individuals were caught in spring, and populations disappeared very soon after the first fat birds were recorded; this could be due either to birds laying down fat very quickly, or to their departing while still lean, or to a change in feeding behavior which makes the birds more difficult to catch. That some Palaearctic migrants in Africa do lay down fat very quickly is well known, but Pearson (1971) thought that some leave their wintering areas, particularly those well to the south of the Sahara, in a relatively lean condition. The same may be true in Jamaica, since Cuba would make a convenient stepping-stone for birds making for Florida, a further 300 km to the north, but we caught too few birds in spring to be able to decide among these possibilities.

Rogers and Odum (1966) found that many migrants arriving in Central America in autumn were extremely lean and may have begun to use non-fat tissue as fuel. Some species were very lean on arrival in Jamaica (*Helmitheros vermivorus*, *Seiurus aurocapillus*), but most were quite heavy on arrival and some (*Dendroica discolor*, *Geothlypis trichas*, *Setophaga ruticilla*) were as fat then as in the spring. Pearson (1971) interpreted the presence of heavy, fat birds in autumn as evidence of migration through the area. He pointed out that this could be confirmed only by retrapping birds which arrive with very little fat, put on weight quickly and then leave, but only very intensive trapping could reveal this pattern. It is also possible that winter residents may lose weight after arrival in autumn, having put on more fat than was used to reach the winter quarters. This seems to happen more often in spring than in autumn, at least in the New World (Rogers and Odum 1966); among Palaearctic species there is less evidence, but Reed and Sedge warblers (*Acrocephalus scirpaceus* and *A. schoenobaenus*) frequently lose weight after arriving in their summer quarters in Britain (G. Hirons, pers. comm.). Presumably it is advantageous for a migrant to put on as much fat as possible before a long flight, even if some of it is not needed if flying conditions prove favorable.

Most birds which winter in the Antilles arrive there from the north (Drury

and Keith 1962). Some of these species winter in northern South America as well as the West Indies, but others, such as Prairie and Black-throated Blue warblers, winter almost exclusively on Caribbean islands. Most Prairie and Black-throated Blue warblers which arrive in Jamaica are probably winter residents. It is possible, however, that some Prairie Warblers pass through Jamaica on their way to winter quarters further east in the Caribbean, since Jamaica lies only a little to the south of the direct line between the western end of the Prairie Warbler's breeding range and islands in the eastern Caribbean. American Redstarts, Yellowthroats and Black-and-white Warblers all winter in northern South America as well as in the Antilles, and the heavy individuals of these species which were caught in autumn may have included some migrating birds. Few heavy Worm-eating Warblers were caught in autumn; this species does not winter in South America (Bond 1971) so most of the birds caught in Jamaica are probably winter residents, though a few may be on migration to Central America. The Ovenbird was the only species in which there was evidence that any birds arrived in a depleted condition; no particularly heavy birds were caught in autumn, although the species does winter in northern South America and some migration through Jamaica might have been expected.

A notable feature in most species was the low level of fat carried through the winter; median fat scores for the months November through February were between 1 and 4. Leck (1972) suggested that migrants in Panama were under greater feeding pressure than residents, particularly in bad weather, and if this were also true in Jamaica, it might explain the low fat levels carried by migrants during the winter. However, in Jamaica at least, there is little if any competition between migrants and residents (Lack and Lack 1973), and most resident species are fatter during the winter than during the breeding season (Diamond 1974). Residents do not show any spring fattening comparable to that of migrants. Most begin to breed at the same time as the migrants lay down fat, presumably in response to the increase in insect numbers which begins in February and March.

In addition to the small fat deposits carried by most species in winter, 2 species, the Black-and-white Warbler and American Redstart, were also lighter than birds weighed in summer on their breeding grounds. Comparisons between Jamaican and North American weights must be treated with caution, since the origin of the Jamaican wintering birds is not known. It is worth pointing out that warblers may well be leaner and lighter in winter than in summer; a similar suggestion was made by Moreau (1944) in comparing the weights of Palaearctic migrants in Europe with those in Africa. In both cases the comparison is difficult because there are so few published weights of breeding birds.

SUMMARY

Weights and fat scores are described for 7 species of migrant parulids mist-netted in Jamaica in 1970–72.

Weights were variable in autumn in most species, some of which may have been on migration; most autumn arrivals were probably winter residents. Fat levels and weights were low during the winter and 2 species (Black-and-white Warbler and American Redstart) were significantly lighter than birds caught in June and July in Pennsylvania.

Mean weights of all species increased in spring, though few birds were trapped then and it is possible that some individuals left Jamaica with low fat levels.

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Appendix

Mean Weights (g) of Migrant Parulid Warblers in Jamaica

		n	$\bar{x}$	s^2	max
Black-and-white Warbler	♂	14	9.25	0.2	10.0
Mniotilta varia	♀	30	9.5	0.2	13.0
Swainson's Warbler		18	15.0	1.1	17.5
Limnothlypis swainsonii					
Worm-eating Warbler		37	13.0	0.8	15.25
Helmitheros vermivora					
Tennessee Warbler		3	8.5	0.1	–
Vermivora peregrina					
Northern Parula	♂	7	7.0	0.7	–
Parula americana	♀	10	7.0	0.3	–
Magnolia Warbler		6	7.75	0.9	–
Dendroica magnolia					
Cape May Warbler		13	9.25	0.3	10.0
Dendroica tigrina					
Black-throated Blue Warbler	♂	7	9.0	0.2	–
Dendroica caerulescens	♀	19	8.75	0.4	12.75
Black-throated Green		9	7.5	0.4	–
Warbler *Dendroica virens*					
Blackburnian Warbler		1	8.75	–	–
Dendroica fusca					
Yellow-throated Warbler		2	8.5	–	–
Dendroica dominica					
Pine Warbler		1	10.5	–	–
Dendroica pinus					
Blackpoll Warbler		1	13.5	–	–
Dendroica striata					
Prairie Warbler	♂	17	7.5	1.3	11.25
Dendroica discolor	♀	18	6.75	0.3	8.0
Palm Warbler		3	9.5	0.2	–
Dendroica palmarum					
Ovenbird		63	19.25	3.2	25.5
Seiurus aurocapillus					
Northern Waterthrush		10	15.75	0.6	20.75
Seiurus noveboracensis					
Common Yellowthroat	♂	30	9.75	0.3	11.25
Geothlypis trichas	♀	18	9.25	0.5*	11.5
American Redstart	♂	21	7.5	0.8	11.5
Setophaga ruticilla	♀	28	7.5	1.3	10.25

* Differences between sexes significant different at .01 level.
** Differences significant at .001 level (2-tailed t-test).